Current Viability of Personal Carriage:

A study protocol for a cross-sectional observational study of the hand hygiene habits of first-year nursing students

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Abstract

Background

Countless studies have shown the effectiveness of proper hand hygiene in preventing the spread of healthcare-associated infections. As such, international organizations such as the World Health Organization have outlined guidelines for the distribution of alcohol-based hand rub (ABHR) products in the healthcare setting. While there is an abundance of research on these methods, there are several unexplored distribution methods that may increase healthcare worker compliance and ABHR product availability in the field.

One of these methods for distribution of ABHR, personal carriage, is a method in which healthcare workers may carry individual bottles of ABHR on their person. The cleanliness, compliance levels, and attitudes associated with personal carriage have not been extensively studied. The purpose of this paper is to outline a study protocol to evaluate the current viability of personal carriage as a method of improving hand hygiene access. This study protocol outlines methods which can be followed after the COVID-19 pandemic by a new student.

Methods

This protocol is for a cross-sectional observation of a cohort of first-year nursing students that is given the opportunity to practice personal carriage. By studying the uptake of personal carriage in this cohort, researchers will predict if personal carriage is a viable distribution method of ABHR for healthcare workers of the future.

Researchers give each member of the cohort one bottle of ABHR to use at their own discretion. At the end of one month, the cohort completes a survey to determine the uptake and impact of the personal carriage intervention. In addition, the bottles will be collected, weighed, swabbed, and cultured to measure the amount of ABHR used and to observe for bottle

contamination. If there is high uptake of use in the cohort and the bottles are not significantly contaminated, personal carriage may be a viable distribution method for ABHR in a healthcare setting.

Discussion

In summary, the primary outcome being observed is the uptake of the intervention: does the cohort use their bottles of ABHR? The secondary outcome being observed is the presence of unintended consequences of the intervention: do the bottles become contaminated over a one-month period? High uptake with low contamination is indicative of a successful intervention.

The implications of a successful personal carriage intervention are that personal carriage may be a viable distribution method for ABHR product for healthcare workers. In turn, personal carriage may improve hand hygiene habits among healthcare workers by increasing accessibility to the product at the point of care.

Introduction

Handwashing has been practiced by humankind for thousands of years (Vermeil, et al., 2018). Hand hygiene involves the process of cleaning one's hands with soap and water or ABHR, as well as other antiseptics and substances (Landers, et al., 2015). Clean hands, the result of proper hand hygiene practices, are the most important component of infection prevention in health care (Landers, et al., 2015). The goal of hand hygiene research is to find the most effective methods, best implementation strategies, and evaluation techniques that limit infection for the greatest number of patients.

Effective Methods

The importance of hand hygiene in preventing healthcare-associated infections cannot be understated. Bacteria are found all over the human body; at any point in time, the area from a human fingertip to the elbow could be home to anywhere from 2 million to 10 million bacteria (Landers, et al., 2015). To prevent the spread of these bacteria and healthcare-associated infections, the World Health Organization (WHO) launched their most recent campaign to increase hand hygiene compliance of healthcare workers in 2009 (World Health Organization, 2009a). The WHO recommends hand hygiene at various junctures in care, known as the "5 Moments:" before touching a patient, before a clean or aseptic procedure, after contact involving a bodily fluid exposure risk, after touching a patient, and after touching a patient's surroundings (Kendall, Landers, Kirk, & Young, 2012). In addition to these, the Center for Disease Control and Prevention (CDC) recommends a sixth indication for hand hygiene: hand hygiene after the removal of gloves (Center for Disease Control and Prevention, 2020). For each of these 6 Moments, a 20-30 second procedure should be followed to ensure hands are properly sanitized (World Health Organization, 2009b).

Countless studies have shown the effectiveness of proper hand hygiene methods in preventing healthcare-associated infections. In one study, after performing an assessment on a patient with a nasal MRSA infection, a healthcare worker placed their hand on a petri dish before and after performing proper hand hygiene (Donskey & Eckstein, 2009). The culture plated before hand hygiene was covered with MRSA growth, while the culture plated after hand hygiene displayed no growth (Donskey & Eckstein, 2009). Without proper hand hygiene, infections can be easily transferred between healthcare workers, patients, and visitors, as well as other hospital staff and members of the community.

Implementation Strategies

The WHO (2009c) outlines recommendations for healthcare facilities to increase hand hygiene compliance. The recommendations contain two sets of guidelines for healthcare facilities: hand hygiene distribution infrastructure, including selecting proper ABHR products, and healthcare worker education (World Health Organization, 2009c).

Several organizations in the United States monitor healthcare system adherence to WHO guidelines, such as the CDC. The CDC mandates that healthcare facilities are required to ensure that hand hygiene supplies, such as ABHR and soaps, are readily available in patient care areas (Center for Disease Control and Prevention, 2020). The Joint Commission (TJC), the accrediting body for hospitals in the United States, also plays a role in hand hygiene implementation. TJC enforces that healthcare systems have proper ABHR distribution infrastructure and proper education to ensure healthcare worker compliance (The Joint Commission, 2019).

Evaluation Techniques

The final component of WHO's implementation guide is the importance of evaluation. While each healthcare system may have their own evaluating hand hygiene practice, JCAHO is

also responsible for citing occurrences for hand hygiene noncompliance (The Joint Commission, 2019).

Hand hygiene noncompliance is prevalent in today's healthcare landscape. According to one observational study, only 40-60% of health care workers are compliant with hand hygiene regulations and recommendations, with even less compliance upon entry of patient rooms or before contact with a patient (Baloh, et al., 2018). In addition, based on qualitative interviews, when health care workers evaluate themselves, they often overestimate their own compliance with hand hygiene (Baloh, et al., 2018). For this reason, many researchers are exploring new ways of ensuring and evaluating health care worker compliance with hand hygiene.

Many health care workers exhibit effective hand hygiene habits while they are being watched, but practice with less compliance behind closed doors. In another observational study, researchers found that health care workers exhibited 91.0% compliance when under overt observation, that is, when they knew they were being watched, but exhibited only 49.3% compliance when they under covert observation, that is, when they did not know they were being watched (Yoo, et al., 2018). Similarly, in a quantitative study in which electronic monitoring systems were implemented for various time periods in a hospital setting, health care workers' participation in hand hygiene showed significant increase upon each implementation of the system (Pong, Holliday, & Fernie, 2018). Based on the results of these as well as many other studies, when health care workers are held accountable for their hand hygiene habits, compliance increases.

While hand and hygiene compliance rates fluctuate based on evaluation techniques, they also fluctuate based on the method in which the ABHR is distributed. So far, accessible point of care dispensers are the most effective distribution method of ABHR in a hospital setting

(Landers, et al., 2018). However, there are many methods that could be used to improve hand hygiene compliance, including personal carriage.

Personal Carriage

One of the many options for the distribution of ABHR in the health care setting, personal carriage, is a method of hand hygiene in which health care workers carry individual bottles of ABHR on their person (Kendall, Landers, Kirk, & Young, 2012). The cleanliness, compliance levels, and attitudes associated with personal carriage have not been extensively studied and must be researched more.

Personal carriage provides particularly exciting opportunities for improving hand hygiene compliance among healthcare workers who do not work in hospitals. While there are many guidelines for in-hospital hand hygiene practices, infection prevention among Emergency Medical Services (EMS) has not been extensively studied (Vikke, et al., 2018). One opportunity personal carriage provides is to increase hand hygiene compliance for pre-hospital care. In one observational study of 87 international patient encounters, only 3% of EMS workers performed hand hygiene before touching the patient and only 19% performed hand hygiene after touching the patient (Vikke, et al., 2018). In another survey of over 1,400 EMS workers assessing compliance during the 6 Moments for hand hygiene, only 13% of respondents claimed to clean their hands before every patient interaction (Bucher, Donovan, Ohman-Strickland, & McCoy, 2015). However, the promising fact is that of these respondents, the 25% who brought their own sanitizer were more likely to practice hand hygiene (Bucher, Donovan, Ohman-Strickland, & McCoy, 2015). These findings indicate that personal carriage interventions may increase hand hygiene compliance among EMS workers.

Personal carriage interventions also provide opportunities for community health nursing. For example, hand hygiene is essential when preventing outbreaks among homeless populations. In a survey of homeless individuals during a hepatitis A outbreak, only 81% of respondents reported washing their hands more than twice per day (Buechler, et al., 2020). However, 84% of respondents reported the use of ABHR (Buechler, et al., 2020). This indicates that the distribution of ABHR to homeless populations by community health nurses may increase hand hygiene compliance, thus decreasing infection spread.

The COVID-19 Pandemic

The arrival of the COVID-19 pandemic brought the vital discussion of hand hygiene back into the forefront of healthcare research. In a recent study of hand hygiene in United States acute care hospitals, researchers found that healthcare worker compliance increased 6% at the onset of pandemic school closures in March of 2020 (Moore, Robbins, Quinn, & Arbogast, 2020). However, this compliance dropped back 8% after several months (Moore, Robbins, Quinn, & Arbogast, 2020). New distribution methods, such as personal carriage, may be vital in maintaining compliance hand hygiene compliance during the pandemic and preventing provider burnout of standard precautions.

Rationale: Advantages of a Study Protocol

This project is the development of a study protocol outlining an epidemiological cross-sectional study examining personal carriage in a population of first-year nursing students. A study protocol includes background, guidelines, potential advantages, and potential risks of a proposed study (Al-Jundi & Sakka, 2016). Although the study has not yet been conducted, the presentation of the methods as a study protocol has significant advantages.

Often in the research field, secrecy and competition between researchers creates a race for study completion and lack of collaboration between different teams (Resnik, 2010). However, by publishing study protocols, researchers on different teams may provide feedback to each other to strengthen the studies, as well as form new teams and increase funding sources (Resnik, 2010). Study protocols outline the viability of the project, allow others to replicate the study, and increase awareness of ongoing research in the field (Al-Jundi & Sakka, 2016). For example, during the COVID-19 pandemic, the U.S. National Library of Medicine has been consolidating randomized control trial protocols to increase collaboration and funding for these projects (Clinical Studies Related to COVID-19, 2020). This setup of study protocol consolidation has allowed for rapid publication of pertinent public health information without barriers (Clinical Studies Related to COVID-19, 2020). In addition, study protocols have increased efficiency when seeking potential treatments and vaccines during the pandemic (Clinical Studies Related to COVID-19, 2020).

There are more than 16 guidelines for publishing study protocols (Equator Network, 2020). These may be for patient-reported outcomes, systematic reviews, animal studies, artificial intelligence, and many more. For example, the SPIRIT 2013 Statement outlines standards for protocols of clinical trials (SPIRIT, 2013). Alternatively, the PRISMA-P 2015 Statement outlines the standards of protocols of systematic reviews (Shamseer, et al., 2015). The CONSORT 2010 Checklist outlines both the benefits of study protocols and suggestions of publications to publish them for access, such as the WHO trial registration database, and provides guidelines for writing study protocols for randomized control trials (CONSORT, 2010). As an epidemiological cross-sectional observational study, this Current Viability of Personal Carriage study protocol follows the STROBE guidelines for reporting observational studies (von Elm, et al., 2007).

In the field of hand hygiene research, study protocols are increasingly important. Many researchers follow the study protocol method of publication. For example, Sasko & Smith (2017) presented their methodology completing the study in order to receive feedback prior to publication. This allows for the knowledge evaluation tool presented in the paper to be critiqued and improved by other researchers before the study is carried out (Sasko & Smith, 2017). In another study protocol, researchers presented a literature review of hand hygiene and behavioral framework to compliance along with a methodology on how to apply this knowledge to improving physician hand hygiene compliance (Squires, et al., 2013). These studies are a few examples of the sweeping benefits of publishing study methods as a study protocol before the study is carried out by researchers.

In summary, the viability of personal carriage as an ABHR distribution method in healthcare, both inside and outside the hospital, has not yet been extensively studied. As a study protocol, the following methods are open to review by other researchers so that constructive feedback may be applied to complete a successful study at the conclusion of the pandemic.

Methods and Data Collection

The objective of this study is to evaluate the current viability of personal carriage as a method of improving hand hygiene compliance. The study is a cross-sectional observation of a cohort of first-year nursing students who are given the opportunity to practice personal carriage, which is the act of carrying personal bottles of hand sanitizer on one's person.

Setting

The setting of this study a college of nursing in a Very High Research Activity Carnegie-classified university in the Midwest. As of autumn 2019, the student enrollment at the institution's main campus capped at just over 61,000, with nearly 47,000 of these students being undergraduates. The student population is diverse racially and academically, with nearly 14,000 minority students attending the Columbus campus and over 250 majors spanning 15 colleges to choose from.. The university also has its own medical center on campus. Students may use free public transportation to access the surrounding city, which has a population nearing 1 million (United States Census Bureau, 2019). The combination of the diversity of the student population, diversity of campus resources, and diversity of the urban setting make this institution is an optimal location for this study because the participants will encounter many contaminants and opportunities to practice hand hygiene throughout the month-long trial period.

Participant Selection

The individuals participating in the study cohort are first-year nursing students. In order to be eligible for the cohort, students must be in their first-year of the Nursing Traditional Bachelor of Science in Nursing program. The number of students who meet this requirement every year is between 160 and 170 students. Most of these students will be sophomores, but some may be juniors. Both sophomores and juniors are invited to participate so long as they are

first-year students in the Traditional BSN program. Every student who meets these criteria is invited to participate.

The first-year nursing cohort makes for an optimal study group because the participants represent the future of the healthcare industry. In order to evaluate the viability of personal carriage as a hand hygiene distribution method, it is essential to implement the intervention with *future* healthcare professionals, who may not have developed biases to other interventions. Furthermore, members of the cohort will likely have enough base knowledge to use the ABHR properly. The selection of this site is due to convenience sample. However, as previously noted, this is also an optimal location to perform the study.

Individuals deemed eligible for the cohort will be notified of the study during a class that all students are required to take. Researchers will reach out to the instructor of the course using the email written in Appendix A. Once an optimal day to introduce participants to the study and begin the trial period has been identified, researchers will prepare for the trial period, as outlined in Figure 1. Ideally, the trial period will take place during the semester of their first clinical rotation.

Figure 1: Trial Period Timeline

Study period

Study Date	Task
Day 1	Brief participants and hand out hand sanitizer
Days 1-30	Participants use hand sanitizer as they please;
Day 30	Collect hand sanitizer bottles and administer survey

Analysis phase

Obtain cultures
Analyze survey data

The Trial Period

The supplies needed for the trial period include 170 bottles of hand sanitizer containing 2fl oz of ABHR product in each. Each bottle will need to be numbered 1-170, so that each post-survey can be matched with the bottle that the same participant used. In addition, 170 rubber carrying cases are needed so that each participant may hook their personal carriage bottle onto their backpacks or clothing if they choose. Finally, 170 sterile specimen baggies are needed to ensure that there is no additional contamination to the bottles upon collection. An initial weight of one of the bottles will also need to be obtained.

Once all supplies are gathered, the researcher will introduce the study to all potential participants who have attended class on the day preferred by the course instructor. The researcher will read the following script:

> "Hello fellow nursing students! My name is [researcher] and I am a [grade] here at the College of Nursing. [Research mentor] and I are conducting a research study about the state of personal carriage, which is the practice of carrying a bottle of hand sanitizer with you on your person. I am hoping all of you will want to participate! In this study, we will be passing out bottles of hand sanitizer for you to use at your own discretion. (Hold up a bottle to demonstrate). In one month, I will return and collect the bottles. In addition, I will give you a 2-minute multiple choice survey to ask questions like, 'how often did you use the hand sanitizer' and 'did you like the product.' I will not be collecting any identifying information about you, so there will not be any ethical risks associated with finding out each other's results. The only health risks would be spreading germs that are carried on the bottle, but this would not be different than any other object you touch during the day. The benefits of participating in the study are: you get your own bottle of hand sanitizer for a

month, and you may discover a new favorite method of hand hygiene! This is a voluntary study, and you have the right to withdraw at any time. My contact information and [research mentor's] contact information will be handed out with the bottles."

After allowing time for questions, the researcher will distribute the personal carriage bottles and accompanying rubber carrying cases to all members of the first-year nursing cohort who wish to participate. No further education will be provided about personal carriage or hand hygiene, as this study is the examination of the existing attitudes and behaviors of the students, not post-education attitudes and behaviors.

During the trial period, the researcher will perform step 1 of the data collection process, as described below. This step is needed to finalize question 5 of the post-intervention survey before the survey is administered.

After one month, the researcher will return to collect the bottles and distribute the post-intervention survey. The collection process will be as follows. Participants will form a single-file line in front of the researcher. The researcher will instruct participants to examine their bottle one last time so they remember about how much of the bottle they used (they will indicate this on the survey). For each participant in line, the researcher will hold out an open sterile specimen baggie for the participant to drop their bottle, and rubber carrying case, if it was used, into. Once sealed, the researcher will write a participant number on the outside of the baggie. Then, the researcher will write the corresponding participant number on a blank survey and hand this to the participant. Participants will complete the surveys and return them to the researcher.

Appendix B outlines the questions for the post-trial-period participant survey. Each survey document will also include a blank area labeled "researcher use only" so that the weights,

culture results, and data analysis of each bottle can be recorded on the document with the corresponding participant number.

Data Collection

Step by step processes for data collection are outlined in Appendix C.

Determining the volume and weight of the bottles (pre-intervention):

Step 1 of the data collection process will be performed by the researcher during the trial period, before the post-intervention survey is administered. The supplies needed for pre-survey data collection include: one unopened bottle of ABHR identical to the bottles given to the participants, and a scale sensitive to 0.001g.

Determining the usage and contamination of the bottles (post-intervention):

Steps 2-12 of the data collection process will be performed by the researcher after the trial period, once the post-intervention survey has been administered and the ABHR bottles have been collected from the participants. The supplies needed for post-survey weight and contaminant data collection include: one unopened bottle of ABHR identical to the bottles given to the participants, 170 petri dishes filled with a non-selective agar, as well as 510 sterile cotton-tipped applicators, sterile water, and a scale sensitive to 0.001g (Ismail, et al., 2013). An incubator is also needed (Rawlinson, Circ, & Cloutman-Green, 2019). For each of the bottles, the steps outlined in Appendix C will be observed to weigh the bottles and grow cultures, using the recommendations of Rawlinson, Ciric, and Cloutman-Green (2019).

Data Analysis

The primary outcome that the researchers are observing is the uptake of the intervention, that is, does the cohort use their bottles of ABHR? The secondary outcome that the researchers are observing is the presence of unintended consequences of the intervention, that is, do the personal carriage bottles of ABHR become contaminated over the one-month period? Results yielding high uptake with low contamination are indicative of a successful intervention. Through data analysis of the primary outcome, secondary outcome, and additional survey responses, researchers will assess the demographics of the cohort, the confidence of the cohort regarding their prior knowledge of hand hygiene practices, the level of contamination on the ABHR bottles, and the usage levels of the product by the cohort.

Preliminary data analysis will be performed for each survey document/participant number using the steps outlined in Appendix D. Descriptive statistics including mean and standard deviations will be calculated for all continuous variables, including hours worked in patient care outside the clinical time. On the survey, mean and standard deviation will be calculated for Likert type questions. In addition, since these questions are on ordinal scales, the researcher will report median and interquartile range. Frequencies will be reported for categorical variables such as storage habits, technique habits, and methods to increase usage such as scent.

Discussion

Limitations

In addition to the limitations mentioned in Appendix D, there are several potential limitations to the method of weight as a measurement of product usage. Drawbacks of using weight for the product usage measurement include:

- Members of the cohort sharing their personal ABHR product with other individuals
- Members of the cohort may lose their personal ABHR bottle
- All bottles may not have weighed exactly the same before they were ever even opened
- Inconsistency in drop size when members of the cohort dispense the ABHR product

Researchers cannot control what participants do with their bottles on their own time during the trial period, and it is nearly impossible to ensure every bottle has identical amounts of product, especially without introducing new contamination to the bottles. However, inconsistency in drop size can be remedied by a specialized cap that dispenses the same amount of ABHR product with every squeeze. Once a standardized procedure for personal carriage has been studied and documented by the WHO, research and development of this special cap will be aimed at dispensing the exact recommended amount of product.

Other limitations to the study include:

- Some students may be absent from class for the introduction of the study/first day of the trial period, and/or for the collection of the bottles/last day of the trial period, thus excluding these students from the cohort
- Students may also forget to bring their bottles back on contamination day
- The non-selective agar may not grow all types of microorganisms, thus potentially missing certain types of contamination

- ABHR may evaporate if the cap of the bottle is left open, thus skewing the data for actual weight used
- As mentioned Appendix D, self-reported participant data is likely to be inaccurate

One improvement that could be made to this study is the use of an automated cap measurement system. Not unlike an adherence pill cap, this automated system would count every time the bottle of ABHR was opened (Aldeer, 2018). A system such as this would result in a much more exact number for survey questions 5 and 7. In addition, as other studies have shown, study participants are much more likely to perform hand hygiene if they know they are being watched (Yoo, et al., 2018). The implementation of an automated cap measurement system may therefore increase healthcare worker compliance with hand hygiene in an inpatient, community, or EMS setting.

Other improvements that could be made to this study include the use of a larger cohort, or the use of multiple cohorts in different locations. Increasing data points would give the researcher a much larger scope for the project, and a much firmer ground to stand on when requesting funding for further research into personal carriage following a successful intervention.

Ethical Considerations

Due to the relationship between members in the cohort separate from the study, there are several ethical considerations to be noted. If results are released showing contamination of the bottles, disclosing the findings may discourage frequent hand hygiene behaviors of the cohort, even by other ABHR distribution methods. However, because the results will be reported in aggregate, the results pinpointing individual deviations or contamination will not be shared with individual students. Therefore, these ethical risks are minimized by keeping the study double

blinded. Participant names are never collected at any point during the study, thus keeping data completely anonymous.

Impact

Personal carriage poses a valuable opportunity from a research perspective. This study provides an overview of the current attitudes and behaviors of future healthcare professionals, thus introducing personal carriage to the ever-evolving field of hand hygiene research. Due to the lack of research about personal carriage, there is very little to compare the results of this study to. However, the potential that personal carriage has to make an impact on hand hygiene practices cannot be overstated.

The current standard of hand hygiene protocol in the healthcare setting is point of care distribution stations. These are found both outside and inside of patient rooms in the hospital so that healthcare workers can practice point of care hand hygiene. One exciting aspect of personal carriage is the ability to bring ABHR into a multitude of healthcare settings, not just hospitals. Paramedics and community health nurses, for example, can use personal carriage to bring ABHR into the field, thus preventing the spread of infection at the very initiation of care. In addition, distribution of personal carriage ABHR bottles to homeless individuals may decrease the spread of infection among this population.

Due to the COVID-19 pandemic, the methods outlined in this study protocol cannot yet be safely performed. Students in the study cohort cannot be safely gathered to obtain and return their personal carriage bottles of ABHR. In addition, the unknown potential for contamination of the personal carriage bottles provides a risk for transmission of the COVID-19 virus. However, using this study protocol, a student researcher of the future will be able to perform this study and share a plethora of new information with the hand hygiene field.

References

Aldeer, M. J. (2018). A review of medication adherence monitoring technologies. *Applied System Innovation*, 14.

Al-Jundi, A., & Sakka, S. (2016). Protocol Writing in Clinical Research. *Journal of Clinical & Diagnostic Research*.

Baloh, J., Thom, K. A., Perencevich, E., Rock, C., Robinson, G., Ward, M., . . . Reisinger, H. S. (2018). Hand hygiene before donning nonsterile gloves: Healthcare workers' beliefs and practices. *American Journal of Infection Control 000*, 1-6.

Bucher, J., Donovan, C., Ohman-Strickland, P., & McCoy, J. (2015). Hand Washing Practices Among Emergency Medical Services Providers. *Western Journal of Emergency Medicine*, 727-735.

Buechler, C., Ukani, A., Elsharawi, R., Gable, J., Petersen, A., Franklin, M., . . . Bryce, R. (2020). Barriers, beliefs, and practices regarding hygiene and vaccination among the homeless during a hepatitis A outbreak in Detroit, MI. *Heliyon*.

Bureau, U. S. (2019). *QuickFacts: Columbus city, Ohio.* Retrieved from United States Census Bureau: https://www.census.gov/quickfacts/columbuscityohio

Clinical Studies Related to COVID-19. (2020). Retrieved from U.S. National Library of Medicine: https://clinicaltrials.gov/ct2/results?cond=COVID-19

CONSORT. (2010). CONSORT 2010 Explanation and Elaboration. *CONSORT: Transparent Reporting of Trials*. Retrieved from http://www.consort-statement.org/checklists/view/32--consort-2010/126-protocol

Donskey, C. J., & Eckstein, B. C. (2009). The Hands Give It Away. *The New England Journal of Medicine*.

Ismail, R., Aviat, F., Michel, V., Le Bayon, I., Gay-Perret, P., Kutnik, M., & Federighi, M. (2013). Methods for Recovering Microorganisms from Solid Surfaces Used in the Food Industry: A Review of the Literature. *International Journal of Environmental Research and Public Health*, 6169-6183.

Kendall, A., Landers, T., Kirk, J., & Young, E. (2012). Point-of-care hand hygiene: Preventing infection behind the curtain. *American Journal of Infection Control 40*, S3-S10.

Landers, T., Ellingson, K., Grow, M. A., Kendall, A., Marx, J. F., Pincock, T., . . . Steed, C. (2015). *Guide to Hand Hygiene Programs for Infection Prevention.* Washington, DC: Association for Professionals in Infection Control and Epidemiology.

Moore, L. D., Robbins, G., Quinn, J., & Arbogast, J. (2020). The impact of COVID-19 pandemic on hand hygiene performance in hospitals. *American Journal of Infection Control*.

Network, E. (2020). *Enhancing the Quality and Transparency of Health Research*. Retrieved from EQUATOR Network: https://www.equator-network.org/?post_type=eq_guidelines&eq_guidelines_study_design=study-protocols&eq_guidelines_clinical_specialty=0&eq_guidelines_report_section=0&s=+

Pong, S., Holliday, P., & Fernie, G. (2018). Effect of intermittent deployment of an electronic monitoring system on hand hygiene behaviors in health care workers. *American Journal of Infection Control 000*, 1-5.

Prevention, C. f. (2020, January 30). *Hand Hygiene in Healthcare Settings: Guidance.* Retrieved from Center for Disease Control and Prevention: https://www.cdc.gov/handhygiene/providers/guideline.html

Rawlinson, S., Ciric, L., & Cloutman-Green, E. (2019). How to carry out microbiological sampling of healthcare environment surfaces? A review of current evidence. *Journal of Hospital Infection*, 363-374.

Resnik, D. B. (2010). Openness versus Secrecy in Scientific Research Abstract. *HHS Public Access*.

Sasko, L., & Smith, S. (2017). A study protocol for assessing nurses knowledge of the five moments for hand hygiene (5MHH) program. *Respirology*, 266-266.

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., . . . Group, P.-P. (2015). Preferred reporting items for systematic review and meta-analysis protocols. *PRISMA-P Explanation and Elaboration*.

SPIRIT. (2013). Standard Protocol Items: Recommendations for Interventional Trials. *SPIRIT 2013 Explanation & Elaboration*.

Squires, J., Suh, K., Linklater, S., Bruce, N., Gartke, K., Graham, I., . . . Grimshaw, J. (2013). Improving physician hand hygiene compliance using behavioral theories: a study protocol. *Implementation Science*.

The Joint Commission (2019). *Focus on Improving Hand Hygiene Compliance to Protect Patients and Health Care Workers.* Retrieved from The Joint Commission: https://www.jointcommission.org/resources/news-and-multimedia/blogs/on-infection-prevention-control/2019/09/focus-on-improving-hand-hygiene-compliance-to-protect-patients-and-health-care-workers/

Vermeil, T., Peters, A., Kilpatrick, C., Pires, D., Allegranzi, B., & Pittet, D. (2018). Hand hygiene in hospitals: anatomy of a revolution. *Journal of Hospital Infection*, https://doi.org/10.1016/j.jhin.2018.09.003.

Vikke, H. S., Vittinghus, S., Giebner, M., Kolmos, H., Smith, K., Castren, M., & Lindstrom, V. (2018). Compliance with hand hygiene in emergency medical services: an international observational study. *Emergency Medicine Journal*.

von Elm, E., Altman, D., Egger, M., Pocock, S., Gotzsche, P., & Vandenbroucke, J. (2007). *The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.*

World Health Organization (2009c). *Guide to Implementation: A Guide to the Implementation of the WHO Multimodal Hand Hygiene Improvement Strategy.* World Health Organization.

World Health Organization(2009a). *Handy Hygiene: Why, How & When?* World Health Organization.

World Health Organization (2009b). *How to Handrub.* Retrieved from World Health Organization: https://www.who.int/gpsc/5may/How_To_HandRub_Poster.pdf accessed 4/21/2021.

Yoo, E., Ursua, L., Clark, R., Seok, J., Jeon, J., & Kim, H. B. (2018). The effect of incorporating covert observation into established overt observation-based hand hygiene promotion programs. *American Journal of Infection Control 000*, 1-5.

Appendix A

Dear [instructor],

My name is [researcher] and I am a student in the BSN honors program. I am reaching out with an opportunity for your first-year students to participate in my research study.

I am conducting a cross-sectional observational research study in which I hope to provide each of your students a 2fl oz bottle of hand sanitizer during one of your in-person lectures. For a period of one month, the students may use this bottle at their discretion. After one month, I will return to your class to collect the bottles and distribute a short post-survey.

I have attached a copy of my introductory script which I will read to the students on the first day I come in, and a copy of my survey which I will distribute to the students on the second day I come in.

Do you have a date in class where I could come introduce my project and distribute hand sanitizer to those who consent to participate?

Thank you for your time,

[researcher]

[researcher's credentials and contact information]

Appendix B

BACKGROUND INFORMATION:

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1. **Participant number (listed on your bottle of ABHR):** ☐

2. **Do you work performing patient care outside of clinical? (For example, in a hospital or nursing home as a nursing assistant)**
   ☐Yes
   ☐No

   Indicate how many months you have worked in patient care (if you have not worked in patient care outside of clinical, indicate "0 months").

   ☐

3. **It is difficult for you to adhere to a hand hygiene routine in your day-to-day life because of…**

	←not relevant ---------- very relevant→									
A. Forgetfulness	1	2	3	4	5	6	7	8	9	10
B. Lack of time	1	2	3	4	5	6	7	8	9	10
C. Damaged skin	1	2	3	4	5	6	7	8	9	10
D. Inaccessibility (not enough ABHR dispensers around campus/in your day-to-day life)	1	2	3	4	5	6	7	8	9	10

4. **How confident are you in your knowledge about and ability to practice hand hygiene?**

   ←I know nothing about hand hygiene ---------- I feel like an expert on hand hygiene→

   1 2 3 4 5 6 7 8 9 10

YOUR PERSONAL CARRIAGE EXPERIENCE:

5. **How many times did you use your personal bottle of ABHR** (finalize this question before giving the survey using the method indicated in Data Collection step 1)**:**
   - ☐ Never
   - ☐ 1 - X times (X = amount of drops totalling 10% of the bottle)
   - ☐ X - XX times (XX = amount of drops totalling 20% of the bottle)
   - ☐ XX – XXX times (XXX = amount of drops totalling 30% of the bottle)
   - ☐ XXX – XL times (XL = amount of drops totalling 40% of the bottle)
   - ☐ XL – L times (L = amount of drops totalling 50% of the bottle)
   - ☐ L – LX times (LX = amount of drops totalling 60% of the bottle)
   - ☐ LX – LXX times (LXX = amount of drops totalling 70% of the bottle)
   - ☐ LXX – LXXX times (LXXX = amount of drops totalling 80% of the bottle)
   - ☐ LXXX – XC times (XC = amount of drops totalling 90% of the bottle)
   - ☐ XC – C times (C = amount of drops totalling 100% of the bottle)
   - ☐ More than C times

6. **About what percentage of the bottle would you say you used?** ☐

7. **About how many days has it been since you last used your bottle?** ☐

8. How often did you use your provided personal bottle of ABHR in each situation (if your bottle ran out, how often did you use it in each situation before it ran out):

		←never--------personal carriage was my most-used method of hand hygiene during clinical →
A.	In a clinical setting (either at clinical or at a job as a nursing assistant)	1 2 3 4 5 6 7 8 9 10
		←never----------every time I was in class→
B.	In class	1 2 3 4 5 6 7 8 9 10
		←never----------before every meal→
C.	Before eating	1 2 3 4 5 6 7 8 9 10
		←never----------after every meal→
D.	After eating	1 2 3 4 5 6 7 8 9 10
		←never----------every time I used the restroom→
E.	After using the restroom	1 2 3 4 5 6 7 8 9 10
F.	In what occasion/location did you use your ABHR the most? Describe your most frequent usage situation; does not have to be one of the options described in A-E.	

9. Which method did you use when performing hand hygiene using your bottle?

☐A. Open cap → dispense ABHR → put bottle away → perform hand hygiene
☐B. Open cap → dispense ABHR → perform hand hygiene → put bottle away
☐Another method (please describe below):

---

10. Where did you store your bottle of ABHR during the trial period while NOT in a clinical setting:

☐A. Clipped to outside of backpack
☐B. Inside of backpack
☐C. In pocket
☐Other: _____

11. Where did you store your bottle of ABHR during the intervention while in a clinical setting:

☐A. Scrub pocket
☐B. Clipped to pants
☐C. I did not carry my bottle on my person during clinical
☐Other: _____

12. To what extent did you find this intervention to increase your awareness of other hand hygiene methods, such as ABHR dispensers found around campus?

←this intervention did not affect my awareness of other hand hygiene methods/dispensers around campus					------this intervention greatly increased→ my awareness of other hand hygiene methods/dispensers around campus				
1	2	3	4	5	6	7	8	9	10

(Continued on next page)

EVALUATING THE INTERVENTION:

13. Would you have used your ABHR more if it was scented?

☐Yes
☐No
☐Unsure

14. Do you think personal carriage can improve your own hand hygiene compliance?

☐Yes
☐No
☐Unsure

15. How likely are you to purchase your own bottle of ABHR/practice personal carriage?

←not at all likely ---------- I will definitely be purchasing my own very soon→

1 2 3 4 5 6 7 8 9 10

16. Predict whether or not personal carriage would improve hand hygiene compliance in inpatient clinical settings, such as at Wexner Medical Center:

←would not at all improve compliance -------- would definitely improve compliance→

1 2 3 4 5 6 7 8 9 10

17. Predict whether or not personal carriage would improve hand hygiene compliance in fieldwork clinical settings, such as ambulance runs or community health nursing:

←would not at all improve compliance ----- would definitely improve compliance→

1 2 3 4 5 6 7 8 9 10

Is there a certain setting or situation that you could see personal carriage being particularly useful for?

Appendix C

1. Before administering the post-intervention survey, measure the number of standard-sized drops in each bottle:
    a. Weigh the first unopened bottle of ABHR on the scale.
    b. Open the cap of the bottle. Tip the bottle upside down and lightly squeeze the sides until one singular drop falls out of the bottle.
    c. Weigh the bottle once again.
    d. Empty the bottle completely. If needed, wash and dry the inside of the bottle and cap components to ensure no ABHR is left.
    e. Weigh the empty bottle.
    f. Subtract the weight obtained in step 1c from the weight obtained in step 1a to determine the weight of the drop. This will be considered a "standard-sized drop."
    g. Subtract the weight obtained in step 1e from the weight obtained in step 1a.
    h. Divide the value obtained in step 1g by the value obtained in step 1f. This will yield the number of standard-sized drops present in each full bottle of ABHR.
    i. Adjust question 5 of Appendix B accordingly. For example, if the calculation in step 1h yields the number of standard-sized drops to equal 200, then X in question 5 of Appendix B would equal 20, XX in step 5 of Appendix B would equal 40, and so on.
2. For each participant bottle:
    a. Place an extra sterile collection baggie on the scale.
    b. If the participant used the rubber carrying case and left it on the bottle when placing it into the sterile collection baggie, place an extra rubber carrying case on

the scale. If the participant did not use a rubber carrying case or did not leave it on the bottle when placing it into the sterile collection baggie, skip this step.

c. Place an unopened extra ABHR bottle on the scale.

d. Zero the scale.

e. Weigh the bottle inside its collection baggie. Weight is taken before swabbing so that any excess sterile water rubbed on the side of the bottle during microbial sample collection will not be included in the weight.

f. In the "researcher use only" section, record the resulting weight in grams on the survey document with the corresponding participant number. If the participant used any ABHR, this should show as a negative number on the scale.

g. Repeat Data Collection steps 2a-2f for all bottles.

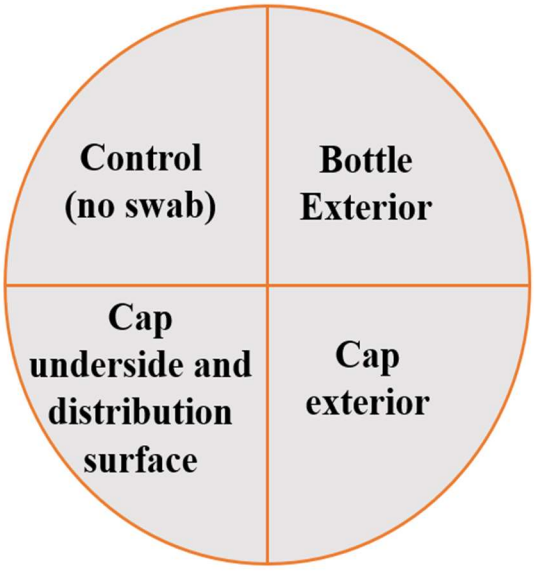
3. Fill each petri dish with a non-selective agar (Rawlinson, Circ, & Cloutman- Green, 2019).

4. Label each petri dish with a corresponding participant number.

5. As shown in Figure 2, divide each petri dish into four quadrants. Label each quadrant as shown in Figure 2.

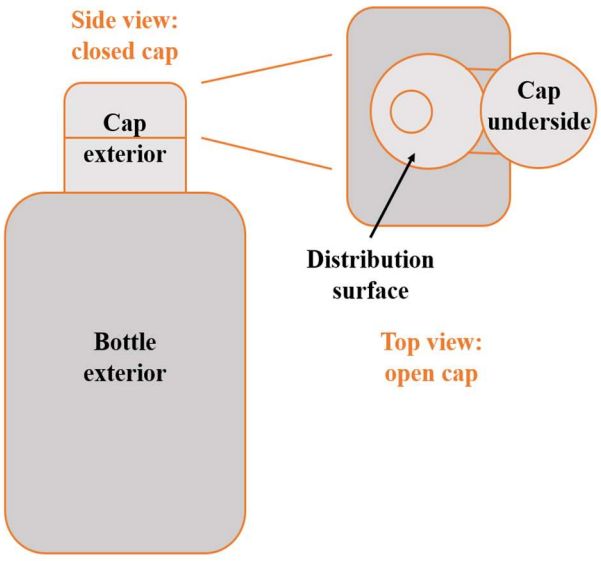
6. In preparation for the procedures of step 7, open a container of sterile water. So long as the sterility of the water is not compromised accidentally during the procedure, the same container of sterile water may be used for each ABHR bottle.

Figure 2: Petri dish quadrants



7. For each participant bottle:
    a. Open the sample baggie without touching the inside surface.
    b. Open the bottom of three sterile cotton-tipped applicators so that the end of the handle may be grabbed with one hand without compromising the sterility of the cotton tip.
    c. Open both petri dish labelled with the participant number that corresponds to the bottle in the now-open sample baggie.
    d. Have a trash can within arm's reach.
    e. Don sterile gloves.
    f. Using only one hand, take the bottle out of the bag.
    g. Using the other hand, remove one of the cotton-tipped applicators and dip the sterile cotton tip into the sterile water (Rawlinson, Circ, & Cloutman-Green, 2019).
    h. Rub the cotton tip of the applicator up and down the bottle exterior, as shown in Figure 3, rolling the applicator to cover all surfaces.
    i. Spread the collected specimen on the “bottle exterior” quadrant as indicated in Figure 5. Roll the applicator to cover all surfaces of the agar within the “bottle exterior” quadrant.

Figure 3: Swabbing locations



j. Discard this applicator in the trash can.

k. Using the same swabbing hand, remove the second cotton-tipped applicator from its package and dip the sterile cotton tip into the sterile water.

l. Rub the cotton tip of the applicator up, down, and over top of the cap exterior, as shown in Figure 3, rolling the applicator to cover all surfaces.

m. Spread the collected specimen on the "cap exterior" quadrant as indicated in Figure 2. Roll the applicator to cover all surfaces of the agar within the "cap exterior" quadrant.

n. Discard this applicator in the trash can.

o. Using the hand already holding the bottle, and without touching the cap underside or the distribution surface (both shown in Figure 3), pop open the cap.

p. Using the applicator hand, remove the third cotton-tipped applicator and dip the sterile cotton tip into the sterile water.

q. Rub the cotton tip of the applicator around the cap underside and the distribution surface, as shown in Figure 3, rolling the applicator to cover all surfaces. Even if the surface still has some ABHR on it, it should still be swabbed.

r. Spread the collected specimen on the "cap underside and distribution surface" quadrant as indicated in Figure 2. Roll the applicator to cover all surfaces of the agar within the "cap underside and distribution surface" quadrant.

s. Discard this applicator, the ABHR bottle, and the sterile collection baggie into the trash can.

t. Cover the petri dish without touching the agar surface.

u. Repeat Data Collection steps 7a-7t for all bottles.

8. Once all petri dishes have been closed, collect the dishes and place them in the incubator.
9. Incubate the petri dishes for 24-72 hours at 37 degrees Celsius (Rawlinson, Circ, & Cloutman-Green, 2019).
10. Upon completion of the incubation period, remove the petri dishes.
11. For each participant number's petri dish:
    a. Assess the "bottle exterior" quadrant. Determine the amount of contaminant growth on this quadrant: no growth, slight growth, moderate growth, or heavy growth.
    b. On the scale of 0-3, with 0=no growth, 1=slight growth, 2=moderate growth, and 3=heavy growth, record the amount of contamination on the survey document with the corresponding participant number. Be sure to label which quadrant dish this contamination value is for (i.e. the "bottle exterior" quadrant).
    c. Assess the "cap exterior" quadrant. Determine the amount of contaminant growth on this quadrant: no growth, slight growth, moderate growth, or heavy growth.
    d. On the scale of 0-3, with 0=no growth, 1=slight growth, 2=moderate growth, and 3=heavy growth, record the amount of contamination on the survey document with the corresponding participant number. Be sure to label which quadrant dish this contamination value is for (i.e. the "cap exterior" quadrant).
    e. Assess the "cap underside and distribution surface" quadrant. Determine the amount of contaminant growth on this quadrant: no growth, slight growth, moderate growth, or heavy growth.
    f. On the scale of 0-3, with 0=no growth, 1=slight growth, 2=moderate growth, and 3=heavy growth, record the amount of contamination on the survey document

with the corresponding participant number. Be sure to label which quadrant dish this contamination value is for (i.e. the “cap underside and distribution surface” quadrant).

12. Repeat Data Collection steps 11a-11f for all petri dishes.

Appendix D

Preliminary data analysis will be performed for each survey document/participant number using the following steps. Appendix E provides a compilation of relevant terminology for the analysis. These terms have been marked in blue.

For each participant:

1. Determine the actual percentage used by dividing the used weight by the total weight.
2. Add the bottle contamination score to the cap contamination score to obtain the total contamination score.
3. Calculate the calculated drops per use:
    a. Approximate the number of times the participant used their ABHR using their response to question 5 of Appendix B. For example, if the bottle contains 200 standard-size drops as determined by Data Collection step 1, and the participant's reported usage is between 20 – 40 times, assume the participant used the bottle 30 times.
    b. Approximate the number of standard-size drops the participant used by multiplying the actual percentage used by the total amount of drops per bottle. For example if the bottle contains 200 standard-size drops as determined by Data Collection step 1, and the participant's actual percentage used is 75%, assume the participant used 150 standard-sized drops.
    c. Divide the value obtained in Data Analysis step 3b (the approximate number of standard-sized drops the participant used) by the value obtained in Data Analysis step 3a (the approximate number of times the participant performed hand hygiene using their bottle of ABHR). For example, if the participant used 150 standard-

sized drops, and their reported usage is between 20-40 times, the calculated drops per use is 150/30=5 drops per use.

4. Calculate calculated drops per day:
    a. Subtract the participant's days since last used from the total number of days in the trial period to obtain an approximate intervention length. For example, if the trail period is 30 days, and the participant reported last using their ABHR 10 days ago, the approximate intervention length would be 20 days.
    b. Divide the amount of standard-sized drops the participant used (calculated in Data Analysis step 3c) by the approximate intervention length (calculated in Data Analysis step 5a). For example, if the participant used 150 standard-sized drops over 20 days, they used 150/20 = 7.5 drops per day.
5. Calculate the reported percentage deviation by subtracting the actual percentage used from the reported percentage used. If the participant's reported percentage used was higher than the participant's actual percentage used, the reported percentage deviation will be a positive value. This indicates that the participant reported too high. If the participant's reported percentage used was lower than the participant's actual percentage used, the reported percentage deviation will be a negative value. This indicates that the participant reported too low. Gathering data about participant accuracy of self-reporting is common in many studies involving hand hygiene compliance.
6. Determine the mean and median of all actual percentage used values from the data set. Create a box plot to represent all actual percentage used values from the data set.
7. Determine the mean and median of all total contamination scores from the data set. Create a box plot to represent all total contamination scores from the data set.

8. Determine the mean and median of all reported percentage deviation values from the data set. Create a box plot to represent all percentage deviation values from the data set.

After the above preliminary data analysis is completed, a collective picture of the intervention begins to form. For example, high mean and median actual percentage used indicate a high intervention uptake among the cohort, while low mean and median contamination scores indicate a low contamination to the ABHR bottles among the cohort. However, while these two main outcomes of the study may already be apparent, the survey questions, combined with the preliminary data analysis, can be used for additional data interpretation.

Survey Question 1

Question 1 is used to match each participant's usage and contamination data to their reporting data.

Survey Question 2: Usage, Contamination, and Reporting Data

Question 2 is used to evaluate whether amount of experience in the healthcare field impacts the level of uptake for the intervention. If participants with a certain amount of healthcare experience have higher mean and median actual percentage used, for example, then more research is needed to establish which aspects of one's healthcare experience contribute to an increase in hand hygiene compliance, so that these aspects may be tailored into pre-intervention education sessions.

Question 2 is also used to evaluate whether amount of experience in the healthcare field impacts the contamination rates of the bottles. If participants with a certain amount of healthcare experience have lower mean and median contamination scores, for example, then more research is needed to establish which aspects of one's healthcare experience contribute to more sanitary

personal carriage practices, so that these aspects may be tailored into pre-intervention education sessions.

Survey Question 3: Usage Data

Question 3 is aimed at assessing the state of hand hygiene among future healthcare professionals. After a mean and standard deviation is calculated for each Likert scale A-D, patterns may appear throughout the data set that indicate common barriers to hand hygiene compliance. For example, if damaged skin is a common barrier among the cohort, then more research is needed to develop ABHR products that do not cause skin breakdown over time. Alternatively, if inaccessibility is a common barrier among the cohort, then more research is needed to develop alternative distribution methods, such as personal carriage, that will make ABHR more accessible, thus increasing hand hygiene compliance.

Survey Question 4: Usage and Contamination Data

Question 4 is used to compare participant hand hygiene knowledge with intervention uptake. To make this comparison, plot one data point for each participant on a graph in (X, Y) format, with the X axis being actual percentage used and the Y axis being confidence score. Assess the graph for a line of best fit to determine if is there a correlation between user confidence/knowledge about hand hygiene practices and intervention uptake. This will address a hypothesis such as "if users are more confident/knowledgeable, then they will have a higher intervention uptake as determined by their actual percentage used." If there is a positive correlation between confident users and increased intervention uptake, then providing education about ABHR and personal carriage hand hygiene practices before the intervention may increase product usage. If higher reported hand hygiene confidence/knowledge correlates to a higher intervention uptake, more research is needed to develop ideal hand hygiene education techniques

that will increase hand hygiene confidence/knowledge across the board, thereby increasing compliance.

This question is also used to compare participant hand hygiene knowledge with drop size. To make this comparison, plot one data point for each participant on a graph in (X, Y) format, with the X axis being confidence score and the Y axis being calculated drops per use. Assess the graph for a line of best fit to determine if is there a correlation between user confidence/knowledge and drop size. This will address a hypothesis such as "if users are more confident/knowledgeable, then they will practice hand hygiene with a smaller drop size." If there is a positive correlation between confident users and a certain drop size, then the researcher can conclude that current attitudes about hand hygiene among future healthcare professionals favor a certain drop size.

Finally, this question is used to compare participant hand hygiene knowledge with contamination rates. To make this comparison, plot one data point for each participant on a graph in (X, Y) format, with the X axis being confidence score and the Y axis being total contamination score. Assess the graph for a line of best fit to determine if is there a correlation between user confidence/knowledge and level of contamination. If there is a positive correlation between confident users and low contamination rates, more research is needed to develop ideal hand hygiene education techniques that will increase hand hygiene confidence/knowledge across the board, thereby making personal carriage practices more sanitary. Additionally, if there are high total contamination scores across the cohort, analysis of question 4 may provide insight as to why the intervention was unsuccessful due to contamination. That is, even if overall total contamination scores are high among the cohort, low total contamination scores among members

of the cohort with high confidence scores provide hope that personal carriage can still be a viable, sanitary practice if proper education is involved.

Survey Question 5: Usage and Contamination Data

Question 5 is primarily used to calculate and compare drop sizes among the cohort. Differing drop sizes may indicate varying levels of prior hand hygiene knowledge, as discussed in the Survey Question 4 section. In addition, this question is used to compare usage frequency to cap contamination score. To make this comparison, plot one data point for each participant on a graph in (X,Y) format, with the X axis being usage frequency and the Y axis being total contamination score. Assess the graph for a line of best fit to determine if there is a correlation between the amount of times a participant opened the bottle and the amount of contamination on the cap. This will address a hypothesis such as "if users open their ABHR bottle more often, it will accrue more contamination." Alternatively, this analysis can be performed using the bottle contamination score or total contamination score instead of the cap contamination score.

Potential sources of error for the analysis of question 5 include inaccurate reporting by cohort members on the survey. It will likely be difficult for participants to remember how many times they used their ABHR, which significantly will skew the results.

Survey Question 6: Reporting Data

As discussed in the Introduction section, one important component of hand hygiene research is participant reporting data. When healthcare workers evaluate themselves, they often overestimate their own compliance with hand hygiene (Baloh, et al., 2018). Question 6 evaluates how accurate participants are in rating their own hand hygiene practices, via the reported percentage deviation calculation.

Survey Question 7: Contamination Data

In addition to being used to calculate the intervention length in Data Analysis step 4a, this question is used to compare days since last used to total contamination score. To make this comparison, plot one data point for each participant on a graph in (X, Y) format, with the X axis being days since last used and the Y axis being total contamination score. Assess the graph for a line of best fit to determine if is there a correlation between days since last used and level of contamination. If there is a strong correlation between days since last used and total contamination score, this may indicate to the researcher that more frequent usage of the ABHR product results in either less or more bottle contamination.

Survey Question 8: Usage and Contamination Data

To fully analyze this question, calculate the mean, median, and standard deviation for each Likert scale A-E. In addition, read through participant responses to part F to garner inspiration for other potential situations in which personal carriage may be beneficial. Via these analyses, the researcher will answer inquiries such as, “in which hand hygiene moment was the personal carriage intervention used most often?”

To evaluate whether frequency of usage in certain situations led to increased bottle contamination, graph plot one data point for each participant on a separate (X,Y) graph for each part of the question A-E, with the X axis being frequency of usage in that situation and the Y axis being total contamination score. Assess the graphs for lines of best fit to determine if there are any correlations between high frequency of usage in certain situations (during clinical, in class, before eating, after eating, and after using the restroom) and level of contamination. This will address a hypothesis such as, “if participants use their ABHR after using the restroom, then there will be more contamination on the bottle and cap.

Survey Question 9: Contamination Data

Question 9 is used to determine which method is most sanitary for a person performing hand hygiene using a personal carriage bottle. Assessing bar graphs of contamination levels for each method A and B will answer the following questions:

- Did participants that use method A have higher contamination rates or lower contamination rates than those who used method B?
- Did participants that used method A have higher contamination rates on the bottle or on the cap?
- Did participants that used method B have higher contamination rates on the bottle or on the cap?

The answers to the above questions will help guide researchers of the future when developing practice guidelines for performing hand hygiene with a personal carriage bottle. In addition, if a participant writes in their own method, compare that participant's total contamination score to the mean and median total contamination scores to determine if that participant's method may also be an option to explore for researchers of the future.

Survey Questions 10: Contamination Data

Question 10 is used to evaluate whether certain carriage/storage practices during the personal carriage intervention affected contamination levels in a non-clinical setting. Assessing bar graphs of contamination levels for each option A, B, and C will answer the following questions:

- Which method yielded the highest amount of bottle contamination?
- Which method yielded the lowest amount of bottle contamination?

The answers to the above question swill help guide researchers of the future when developing practice guidelines for carrying/storing personal carriage bottles while practicing

personal carriage as a method of hand hygiene. In addition, if a participant writes in their own carriage/storage practice, compare that participant's total contamination score to the mean and median total contamination scores to determine if that participant's carriage/storage practice may also be an option to explore for researchers of the future.

Survey Question 11: Contamination Data

Question 11 is to be evaluated identically to question 10, the only difference being that question 11 is specific to a clinical setting.

Survey Question 12: Feedback Data

The remaining survey questions explore more in depth how impactful the intervention was and ask participants to provide feedback on their new attitudes regarding personal carriage and hand hygiene. For question 12, calculating the mean and standard deviation for the Likert scale will give the researcher insight into the impact of personal carriage beyond using it for hand hygiene. For example, even if participants did not use much of their ABHR bottle, carrying it around on their person may have increased their awareness of other opportunities for hand hygiene, such as point of care dispensers in dining halls and other areas around ~~Ohio State's~~ the university campus. This data will give researchers a sense of the scope of impact personal carriage has the potential to make on the landscape of hand hygiene attitudes as a whole.

Survey Question 13: Feedback Data

Graphing the frequency of "yes" and "no" responses to this question will help future researchers tailor their own personal carriage interventions. For example, if a large number of participants indicate that they prefer scented or non-scented product, the usage of said product may increase uptake for future interventions.

Survey Question 14: Feedback Data

Question 14 assesses general uptake of the intervention. A higher frequency of "yes" responses indicates a more impactful intervention. A higher frequency of "no" responses indicates that personal carriage may not be a successful method to implement when trying to increase hand hygiene compliance. Of note, however, a higher frequency of "no" responses does not mean that personal carriage may not be a successful intervention among other populations, such as homeless individuals or EMS workers. In either case, more research is required.

Survey Question 15: Feedback Data

Question 15 assesses the immediate impact of the intervention on the members of the cohort. A high mean, median, and standard deviation of the Likert scale in this question is indicative of a high intervention uptake.

Survey Question 16: Feedback Data

Whereas questions 14 and 15 assess the more immediate impacts of the intervention, questions 16 and 17 evaluate the potential for future impact of the intervention. Calculating the mean, median, and standard deviation for the Likert scale in question 16 will give the researcher insight into the potential for personal carriage to make an impact in the clinical setting. This question is important for the cohort because if healthcare workers of the future believe in the intervention, then the intervention will likely be successful in increasing compliance down the road.

Survey Question 17: Feedback Data

Question 17 asks participants to think of other situations in which personal carriage may be useful. This question is important because even if the cohort does not feel as if personal carriage is pertinent to their own current practice, they still believe there is potential for this hand hygiene method to make an impact elsewhere. Calculating the mean, median, and standard

deviation for the Likert scale in this question will give the researchers insight into how much impact potential personal carriage may have in a variety of settings, according to the cohort. In addition, cohort responses to the open portion of this question may provide inspiration for future personal carriage research endeavors.

Appendix E

- **Actual percentage used**: percentage of total ABHR used by a participant; obtained in Data Analysis step 1
- **Bottle contamination score**: level of microbial growth on the outside of the bottle; determined in Data Collection step 11b
- **Calculated drops per day**: estimated standard-sized drops of ABHR used per day by a participant; obtained in Data Analysis step 4
- **Calculated drops per use**: approximate amount of standard-size drops a participant dispensed every time they practiced hand hygiene; calculated in Data Analysis step 3
- **Cap contamination score**: level of microbial growth on the distribution surface of the bottle; determined in Data Collection step 11d
- **Confidence score**: participant's response to question 4
- **Days since last used**: participant's response to question 7:
- **Reported percentage deviation**: deviation of reported percentage used from actual percentage used; calculated in Data Analysis step 5
- **Reported percentage used**: participant's response to question 6
- **The data set**: list of data from all survey documents and calculations
- **Total weight**: initial weight of ABHR in every bottle in grams; obtained in Data Collection step 1g
- **Usage frequency**: participant's response to question 5
- **Used weight**: weight of ABHR used by a participant in grams; obtained in Data Collection step 3